

On Sea Ice

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covering more than seven percent of the earth's surface sea ice is crucial to the functioning of the biosphere and is a key component in our attempts to understand and combat climate change. With *On Sea Ice*, geophysicist W. F. Weeks delivers a natural history of sea ice, a fully comprehensive and up-to-date account of our knowledge of its creation, change, and function. The volume begins with the earliest recorded observations of sea ice from 350 BC, but the majority of its information is drawn from the period after 1950, when detailed study of sea ice became widespread. Weeks delves into both micro-level characteristics (internal structure, component properties, and phase relations) and the macro-level nature of sea ice (such as salinity, growth, and decay). He also explains the mechanics of ice pack drift and the recently observed changes in ice extent and thickness, an unparalleled account of a natural phenomenon that will be of increasing importance as the earth's temperature rises. *On Sea Ice* will unquestionably be the standard for years to come.

As the Arctic perennial sea ice continues to disappear at an alarming rate, a full understanding of sea ice as a crucial global ecosystem and the effects of its loss is vital for all those working with and studying global climate change. Building on the success of the previous edition, the second edition of *Sea Ice* is now much expanded and in full colour throughout. It includes six completely new chapters with complete revisions of all the chapters included from the first edition. The editors, Professor David Thomas and Dr Gerhard Dieckmann, have once again drawn together an extremely impressive group of internationally respected contributing authors, ensuring a comprehensive worldwide coverage of this incredibly important topic. *Sea Ice*, second edition, is an essential purchase for oceanographers and marine scientists, environmental scientists, biologists, geochemists, and geologists. All those involved in the study of global climate change will find this book to contain a wealth of important information. All libraries in universities and research establishments where these subjects are studied and taught will need multiple copies of this book. On their shelves, truly multidisciplinary approach, world-leading authors and editors, international in scope, covering both Arctic and Antarctic work of vital interest to all those involved in global warming and climate change research. Highly illustrated, full colour book with colour images throughout.

new edition of the leading resource on the arctic and southern oceans with contributions from the world's experts on sea ice sea ice delivers insights into the very latest understanding of sea ice dynamics how we measure and model its extent the ecosystems that depend on sea ice and the effect of climate change on its distribution the book also discusses how sea ice influences the oceanography of underlying waters and the influence that sea ice has on the world's climate this newly revised and updated fourth edition looks at ice based food webs and the impact on global geopolitics as well as changes in human activity in the arctic written by a team of more than 80 of the world's leading experts from 13 countries sea ice includes information on sea ice thickness distribution and snow and surface processes on sea ice the short term and long term dynamics of arctic versus antarctic sea ice current methods of satellite remote sensing of sea ice the ecology of sea ice from microbes to mammals to marine birds the cycling of contaminants across the ocean sea ice atmosphere interface in its new edition sea ice remains the leading multidisciplinary resource on the subject for all policy makers researchers and students with an interest in the polar regions and their role in the world's oceanic systems

ice in the ocean examines sea ice and icebergs and their role in the global climate system it is comprehensive textbook suitable for students pure and applied researchers and anyone interested in the polar regions the oceans and climate the author examines the distribution of sea ice its mechanisms of growth development and decay the thermodynamics and dynamics of sea ice sea ice deformation and ridge building the role of marginal ice zones the characteristics of icebergs and the part played by sea ice in the climate system and in the transport of pollutants an extensive reference list recommendations for further reading and numerous illustrations add to the value of the text

sea ice which covers up to 7 of the planet's surface is a major component of the world's oceans partly driving ocean circulation and global climate patterns it provides a habitat for a rich diversity of marine organisms and is an extremely valuable source of information in studies of global climate change and the evolution of present day life forms increasingly sea ice is being used as a proxy for extraterrestrial ice covered systems sea ice provides a comprehensive review of our current available knowledge of polar pack ice the study of which is severely constrained

by the logistic difficulties of working in such harsh and remote regions of the earth the book's editors Drs Thomas and Dieckmann have drawn together an impressive group of international contributing authors providing a well edited and integrated volume which will stand for many years as the standard work on the subject. Contents of the book include details of the growth microstructure and properties of sea ice large scale variations in thickness and characteristics its primary production micro and macrobiology sea ice as a habitat for birds and mammals sea ice biogeochemistry particulate flux and the distribution and significance of palaeo sea ice. Sea ice is an essential purchase for oceanographers and marine scientists environmental scientists biologists geochemists and geologists all those involved in the study of global climate change will find this book to contain a wealth of important information. All libraries in universities and research establishments where these subjects are studied and taught will need multiple copies on their shelves. David Thomas is at the School of Ocean Sciences University of Wales Bangor UK. Gerhard Dieckmann is at the Alfred Wegener Institute for Polar and Marine Research Bremerhaven Germany.

Sea ice: the latest edition of the gold standard in sea ice references. In the newly revised second edition of *Sea Ice Physics and Remote Sensing* a team of distinguished researchers delivers an in depth review of the features and structural properties of ice as well as the latest advances in geophysical sensors ice parameter retrieval techniques and remote sensing data. The book has been updated to reflect the latest scientific developments in macro and micro scale sea ice research. For this edition the authors have included high quality photographs of thin sections from cores of various ice types as well as a comprehensive account of all major field expeditions that have systematically surveyed sea ice and its properties. Readers will also find a thorough introduction to ice physics and physical processes including ice morphology and age based structural features practical discussions of radiometric and radar scattering observations from sea ice including radar backscatter and microwave emission the latest techniques for the retrieval of sea ice parameters from space borne and airborne sensor data new chapters on sea ice thermal microwave emissions and on the impact of climate change on polar sea ice. Perfect for academic researchers working on sea ice the cryosphere and climatology *Sea Ice Physics and Remote Sensing* will also benefit meteorologists marine operators and high latitude construction

engineers

sea ice physics and remote sensing addresses experiences acquired mainly in Canada by researchers in the fields of ice physics and growth history in relation to its polycrystalline structure as well as ice parameters retrieval from remote sensing observations the volume describes processes operating at the macro and microscale e.g. brine entrapment in sea ice crystallographic texture of ice types brine drainage mechanisms etc the information is supported by high quality photographs of ice thin sections prepared from cores of different ice types all obtained by leading experts during field experiments in the 1970s through the 1990s using photographic cameras and scanning microscopy in addition this volume presents techniques to retrieve a suite of sea ice parameters e.g. ice type concentration extent thickness surface temperature surface deformation etc from space borne and airborne sensor data the breadth of the material on this subject is designed to appeal to researchers and users of remote sensing data who want to develop quick familiarity with the capabilities of this technology or detailed knowledge about major techniques for retrieval of key ice parameters volume highlights include detailed crystallographic classification of natural sea ice the key information from which information about ice growth conditions can be inferred many examples are presented with material to support qualitative and quantitative interpretation of the data methods developed for revealing microstructural characteristics of sea ice and performing forensic investigations data sets on radiative properties and satellite observations of sea ice its snow cover and surrounding open water methods of retrieval of ice surface features and geophysical parameters from remote sensing observations with a focus on critical issues such as the suitability of different sensors for different tasks and data synergism sea ice physics and remote sensing is intended for a variety of sea ice audiences interested in different aspects of ice related to physics geophysics remote sensing operational monitoring mechanics and cryospheric sciences

this book provides in depth information about the sea ice in the arctic at scales from paleoenvironmental variability to more contemporary changes during the past and present centuries the book is based on several decades of research related to sea ice in the arctic and its variability sea ice process studies as well as implications of the sea ice variability on human

activities the chapters provide an extensive overview of the research results related to sea ice in the arctic at paleo scales to more recent scales of variations as well as projections for changes during the 21st century the authors have pioneered the satellite remote sensing monitoring of sea ice and used other monitoring data in order to study monitor and model sea ice and its processes

utterly extraordinary the starkest book i ve read on the impacts of accelerating climate change for a very long time if we re not listening to the likes of peter wadhams then we too are in denial jonathon porritt most of the scientific establishment predict that the north pole will be free of ice around the middle of this century as peter wadhams the world s leading expert on sea ice demonstrates in this book even this assessment of the future is optimistic wadhams has visited the polar regions more often than any other living scientist 50 times since he was on the first ship to circumnavigate the americas in 1970 and has a uniquely authoritative perspective on the changes they have undergone and where those changes will lead from his observations and the latest scientific research he describes how dramatically sea ice has diminished over the past three decades to the point at which by the time this book is published the arctic may be free of ice for the first time in 10 000 years wadhams shows how sea ice is the canary in the mine of planetary climate change he describes how it forms and the vital role it plays in reflecting solar heat back into space and providing an air conditioning system for the planet he shows how a series of rapid feedbacks in the arctic region are accelerating change there more rapidly than almost all scientists and political authorities have previously realised and the dangers of further acceleration are very real a farewell to ice is a report from the frontline of planetary change in the arctic and antarctic by a leading authority presenting incontrovertible scientific data but always in clear language which the layman can easily understand it is one of the most important books published in recent years about the existential challenge which human civilization now faces

discover and explore worlds containing unexpected life as some scientists search for life on the frozen planet of mars others are discovering life in unexpected places here on earth frozen oceans follows the expeditions of polar scientists in the arctic and antarctic as they investigate the life found in and around the ice caps which cover up to 13 percent of the earth s surface

every year during the harsh polar winter the surface of the ocean freezes forming a temporary ice layer called pack ice or sea ice the antarctic is the site of the greatest seasonal event on earth in march the air temperatures drop to as low as 40 f the ocean which turns to ice at 28 7 f starts freezing at the incredible average rate of 2 22 square miles per minute this is the first book to explain in non technical terms and show with color photography the abundance of life on in and under the ice topics include the nature of pack ice pack ice regions of the world life within a block of ice microbiology inside the ice mammals birds and ice scientists are continually being surprised by the abundance of life where no life was expected for many years ice was seen as an obstacle to exploration and a threat to life the ice is now perceived as central to global ocean circulation as well as global climate patterns frozen oceans is a must for anyone with an interest in the polar regions marine biology and the earth s environment

a comprehensive overview of the science involved in automated prediction of sea ice for sea ice analysts researchers and professionals

published by the american geophysical union as part of the geophysical monograph series volume 180 this volume addresses the rapid decline of arctic sea ice placing recent sea ice decline in the context of past observations climate model simulations and projections and simple models of the climate sensitivity of sea ice highlights of the work presented here include an appraisal of the role played by wind forcing in driving the decline a reconstruction of arctic sea ice conditions prior to human observations based on proxy data from sediments a modeling approach for assessing the impact of sea ice decline on polar bears used as input to the u s fish and wildlife service s decision to list the polar bear as a threatened species under the endangered species act contrasting studies on the existence of a tipping point beyond which arctic sea ice decline will become or has already become irreversible including an examination of the role of the small ice cap instability in global warming simulations a significant summertime atmospheric response to sea ice reduction in an atmospheric general circulation model suggesting a positive feedback and the potential for short term climate prediction the book will be of interest to researchers attempting to understand the recent behavior of arctic sea ice model projections of future sea ice loss and the consequences of sea ice loss for the natural and human

systems of the arctic

recent well documented reductions in the thickness and extent of arctic sea ice cover which can be linked to the warming climate are affecting the global climate system and are also affecting the global economic system as marine access to the arctic region and natural resource development increase satellite data show that during each of the past six summers sea ice cover has shrunk to its smallest in three decades the composition of the ice is also changing now containing a higher fraction of thin first year ice instead of thicker multi year ice understanding and projecting future sea ice conditions is important to a growing number of stakeholders including local populations natural resource industries fishing communities commercial shippers marine tourism operators national security organizations regulatory agencies and the scientific research community however gaps in understanding the interactions between arctic sea ice oceans and the atmosphere along with an increasing rate of change in the nature and quantity of sea ice is hampering accurate predictions although modeling has steadily improved projections by every major modeling group failed to predict the record breaking drop in summer sea ice extent in september 2012 establishing sustained communication between the user modeling and observation communities could help reveal gaps in understanding help balance the needs and expectations of different stakeholders and ensure that resources are allocated to address the most pressing sea ice data needs seasonal to decadal predictions of arctic sea ice challenges and strategies explores these topics

panel appointed in 1979 to investigate available information and research needs in field of sea ice mechanics referring especially to engineering activities in and under ice of polar oceans

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margo multiproxy approach for the reconstruction of the glacial ocean surface summarizes the results of the margo international working group with the aim to develop an updated and harmonised reconstruction of sea surface temperatures and sea ice extent of the last glacial maximum oceans the margo approach differs from previous efforts by developing and consistently applying measures of various aspects of reconstruction reliability and by combining faunal and geochemical proxies in 14 papers the volume provides a comprehensive review of earlier work and a series of new proxy specific reconstructions based on census counts of planktonic foraminifera diatoms radiolaria and dinoflagellate cysts as well as on mg ca measurements in planktonic foraminifera the approach of harmonising the calibration and application of different proxies is described in detail various paleothermometry techniques and their results are compared and the challenge of treating sparsely sampled data as the basis for ocean circulation models is addressed the use of stable oxygen isotope composition of foraminiferal shells as a proxy for past sea water composition is comprehensively reassessed and a new approach to the transfer function paleothermometer is presented this volume represents a landmark contribution to the understanding of ice age oceanography as well as the proxies used to reconstruct past ocean states the results will form the basis for forcing and validation of ocean circulation models new regional reconstructions of last glacial maximum ocean temperatures and sea ice cover compilation of new calibration and fossil datasets as well as documentation of techniques and approaches to paleoenvironmental reconstructions comparison of techniques proxies and modelling approaches

sea ice surface temperatures observed at eureka n w t canada during 1949 50 and 1950 51 were used to compute the numerical value of the expression k / ρ where k thermal conductivity L latent heat of fusion and ρ density the numerical value for these combined physical properties of sea ice was found to increase from approximately 0.000047 to 0.00007 during ice growth between 6 november and 22 december from 0.6 to 1 m thickness during the increase from 1.1 to 1.3 m between 20 january and 10 february the value of k / ρ ranged from 0.00007 to 0.00008 and then decreased slightly during the rest of the growth period these variations in the value of k / ρ throughout the winter season were considered as changes in the effective conductivity caused by physical changes and distribution of brine in the sea ice since no observations on sea

ice salinity were made at eureka it was not possible to investigate the effect of the physical properties separately a study on the relation between sea ice accretion and temperature gradient disclosed a correlation coefficient of $r = 0.73$ author

in addition to observations and lab experiments the scientific investigation of the arctic and antarctic sea ice is conducted through the employment of geophysical models these models describe in a numerical framework the physical behavior of sea ice and its interactions with the atmosphere ocean and polar biogeochemical systems sea ice models find application in the quantification of the past present and future sea ice evolution which becomes particularly relevant in the context of a warming climate system that causes the reduction of the arctic sea ice cover because of the sea ice decline the navigation in the arctic ocean increased substantially in the recent past a trend that is expected to continue in the next decades and that requires the formulation of reliable sea ice predictions at various timescales sea ice predictions can be delivered by modern forecast systems that feature dynamical sea ice models the simulation of sea ice is at the center of this thesis a coupled climate model with a simple sea ice component is used to quantify potential impacts of a geoengineering approach termed arctic ice management the skill of current operational subseasonal to seasonal sea ice forecasts based on global models with a varying degree of sea ice model complexity is evaluated and lastly an unstructured grid ocean model is equipped with state of the art sea ice thermodynamics to study the impact of sea ice model complexity on model performance in chapter 2 i examine the potential of a geoengineering strategy to restore the arctic sea ice and to mitigate the warming of the arctic and global climate throughout the 21st century the results obtained with a fully coupled climate model indicate that it is theoretically possible to delay the melting of the arctic sea ice by 60 years but that this does not reduce global warming in chapters 3 and 4 i assess the skill of global operational ensemble prediction systems in forecasting the evolution of the arctic and antarctic sea ice edge position at subseasonal timescales i find that some systems produce skillful forecasts more than 1.5 months ahead but i also find evidence of substantial model biases and issues concerning data assimilation and model formulation chapter 5 deals with the impact of sea ice model complexity on model performance i present a new formulation of the fesom2 sea ice ocean model with a revised description of the sea ice thermodynamics including various

parameterizations of physical processes at the subgrid scale the model formulation grants substantial modularity in terms of sea ice physics and resolution the new system is used for assessing the impact of the sea ice model complexity on the fesom2 performance in different atmosphere forced setups with a specific parameter tuning approach and a special focus on sea ice related variables the results evidence that a more sophisticated model formulation is beneficial for the model representation of the sea ice concentration and snow thickness while less relevant for sea ice thickness and drift i also highlight a dependence of the model performance on the atmospheric forcing product used as boundary conditions in the final part of this thesis i formulate recommendations for future developments in the field of sea ice modeling with particular emphasis on fesom2 and more generally on the modeling infrastructure under development at the alfred wegner institute

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